
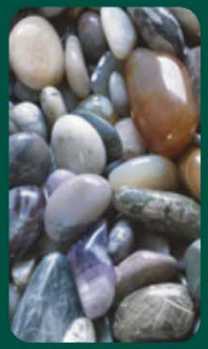

Hydrogeological Characterization of Groundwater Flow in the Columbia River Basalt Group using an Integrated Tool Box

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Doug Geller, R.G.
Groundwater Program Manager, Portland Water Bureau

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Presentation Overview

- Background
- Program Objectives
- Investigations
- Analyses
- Conceptual Model
- Next Steps

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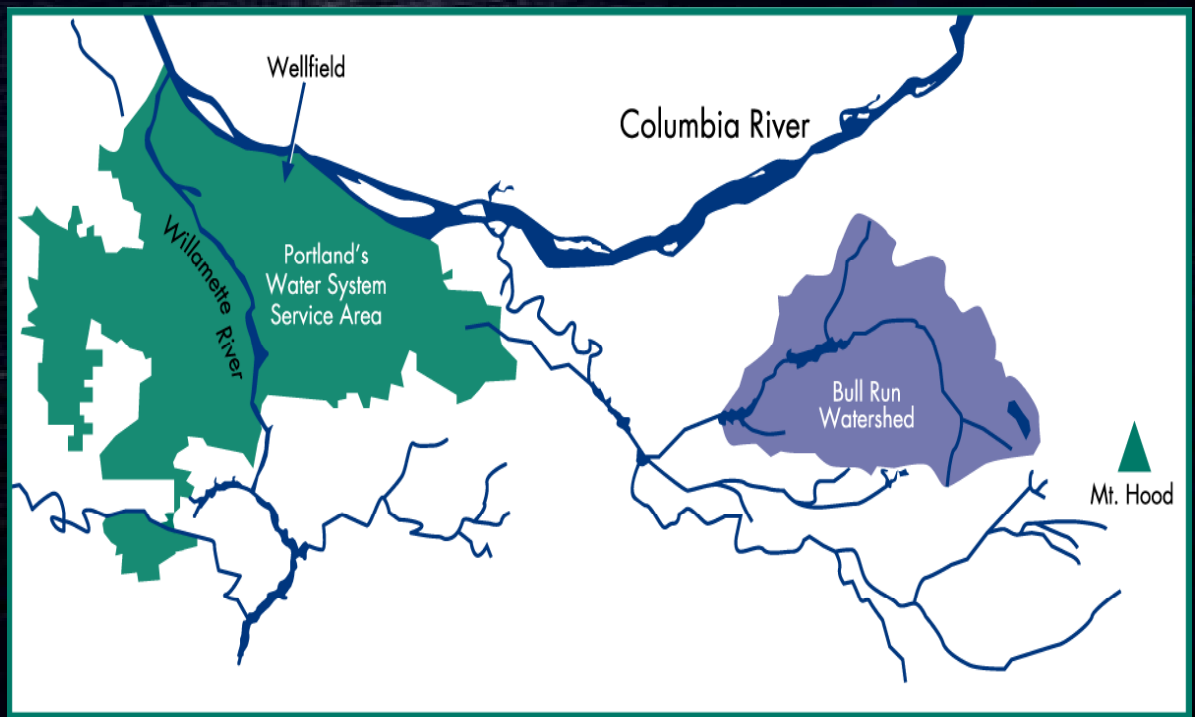
City of Portland Water Supply System

System Overview



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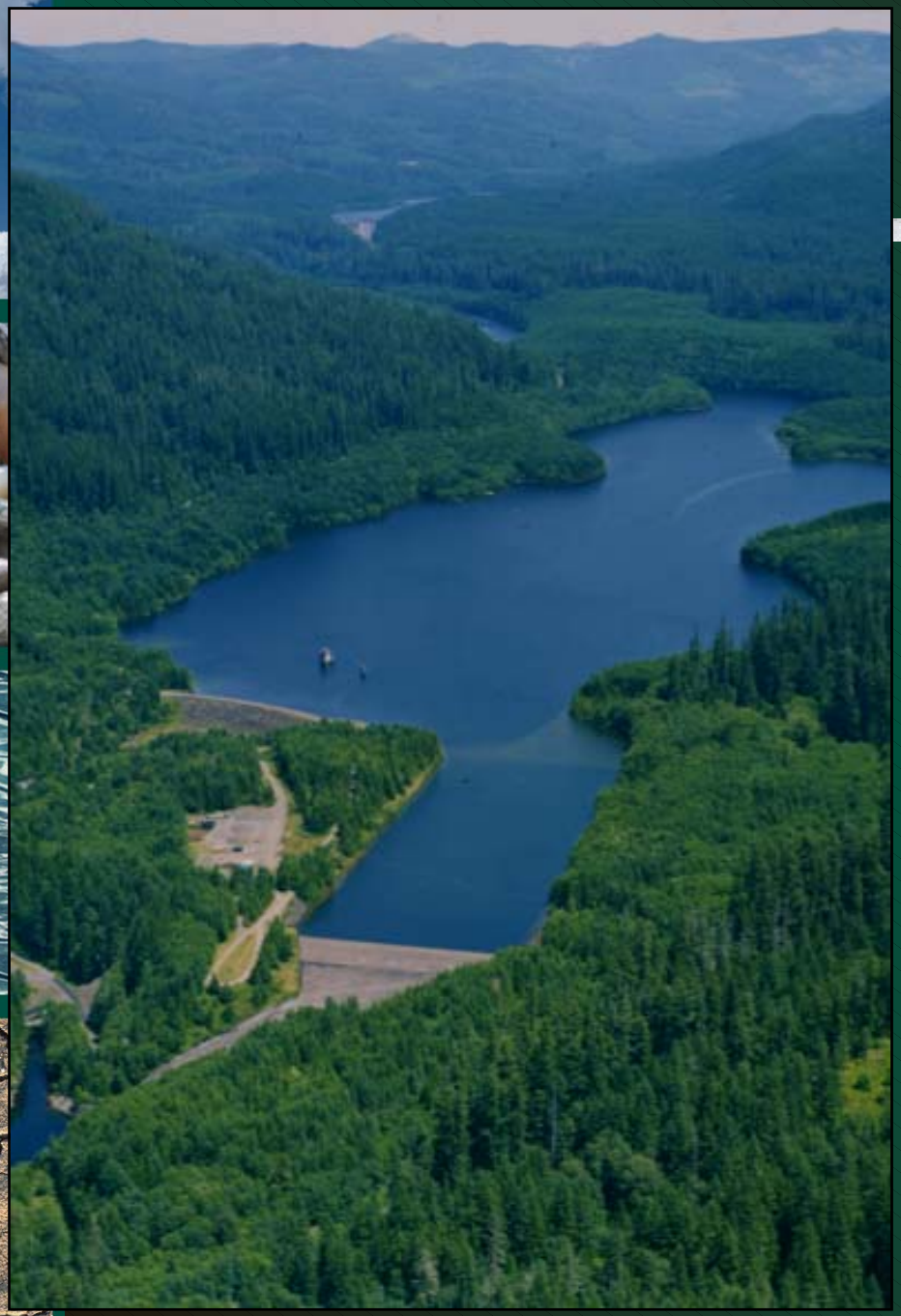
The Bull Run Watershed



- Unfiltered surface water source
- Closed to ALL public access
  - No residents
  - No logging
  - No recreation
- Managed by USFS in cooperation with City of Portland

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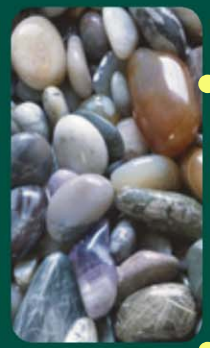

Bull Run Groundwater Supply: Objectives and Background

- Objective
  - Develop supplemental supply 10 to 20 MGD
- Background
  - Study began in 1998
  - Focus on Columbia River Basalt Group aquifers
  - Five wells of varying diameter and depths (up to 800 feet) drilled
  - Well yields up to 2,000 gpm (flowing artesian)

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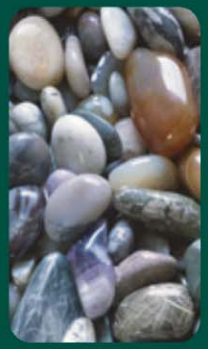

Components of Integrated Approach

- Geology
- Geophysics
- Aquifer Hydraulics
- Groundwater Levels
- Water Budget
- Geochemistry

Outcome = Conceptual Model

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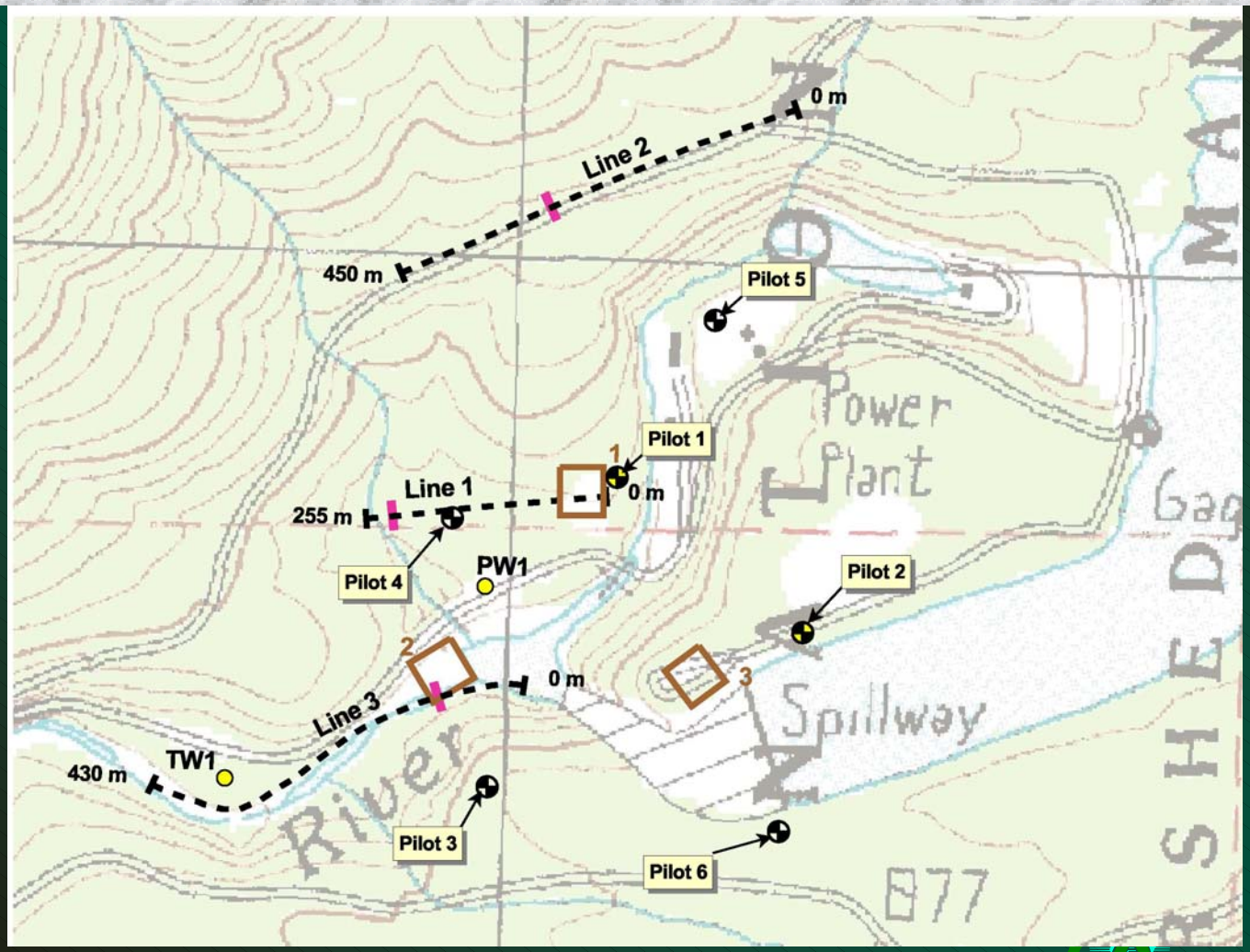
Well Locations and Geophysical Profiles



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Geological Characterization

- Previous Studies
- Regional/Local Mapping
- Core and Rotary Drilling
- Whole Rock Geochemistry
- Borehole Geophysics

Vantage Outcrop

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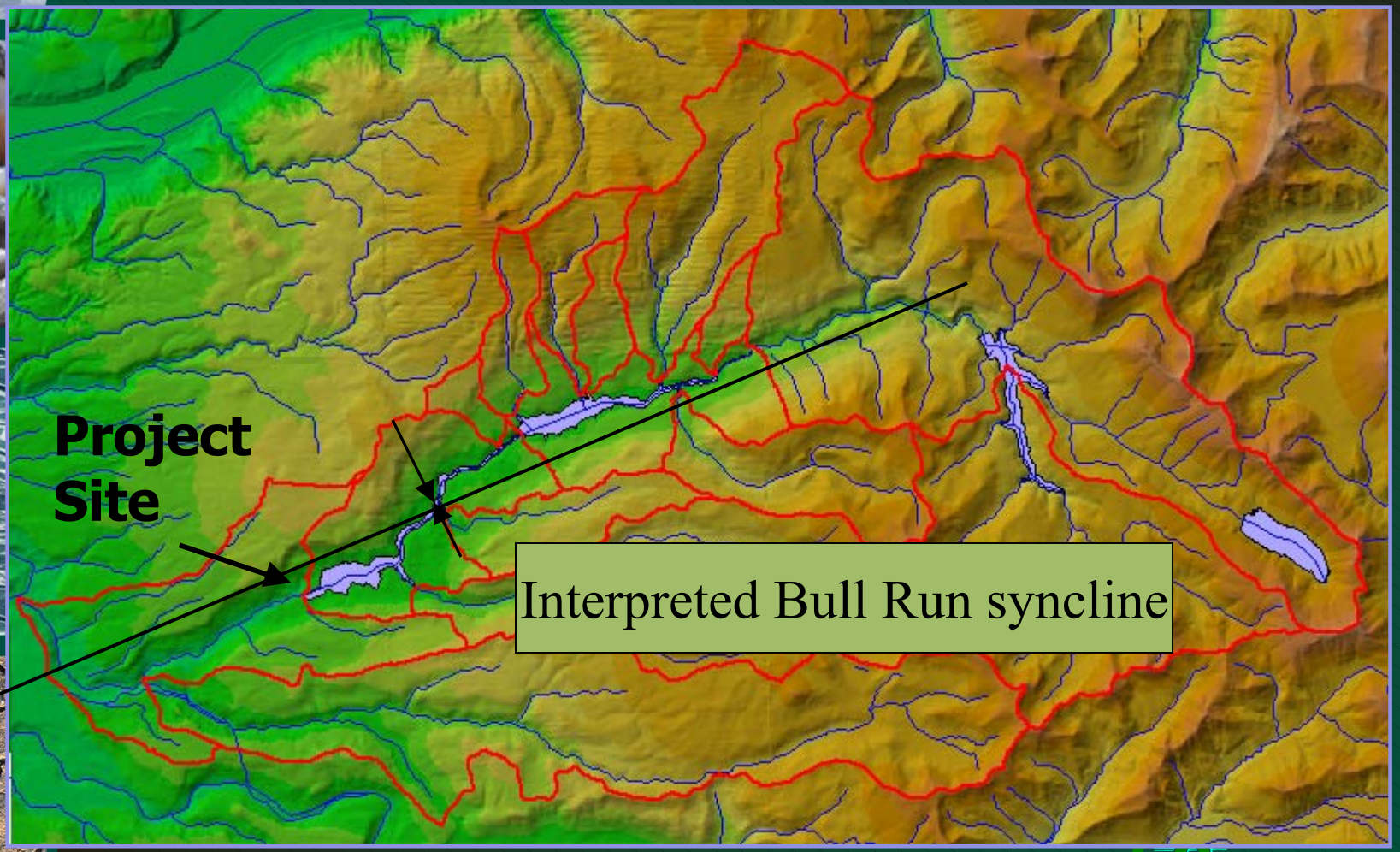
Bull Run Geology



Geological Characterization

Core Hole

Winter Water Flow Top

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Pilot Well Drilling

Shut-in pressure ~ 56 psi

Pilot Well 1 – Flowing at 2,000 gpm

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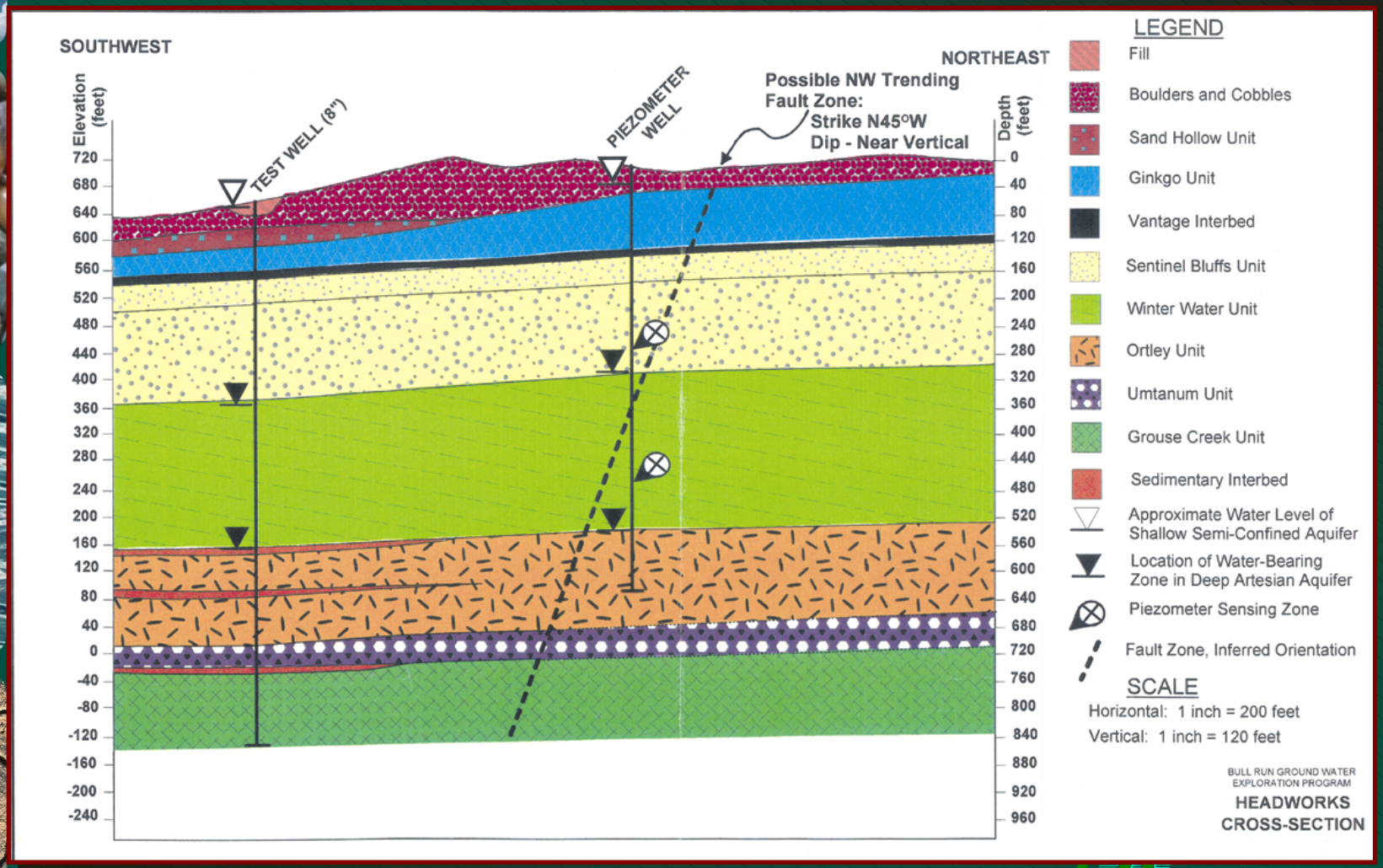
Local Stratigraphy



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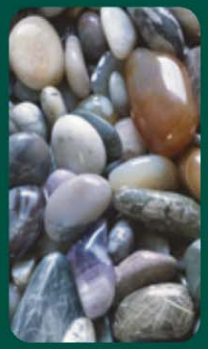

Borehole Geophysical Logging

- Variety of Tools Used to Characterize Geology and Hydrogeology of Test Wells
  - Video
  - Borehole Televiewer/Fracture Mapping
  - Caliper
  - Natural Gamma
  - Resistivity/SP
  - Fluid Temperature & Conductivity
  - Flow Meter

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Geophysical Logging – PW-1

Overflow from PW-1
1,000 gpm

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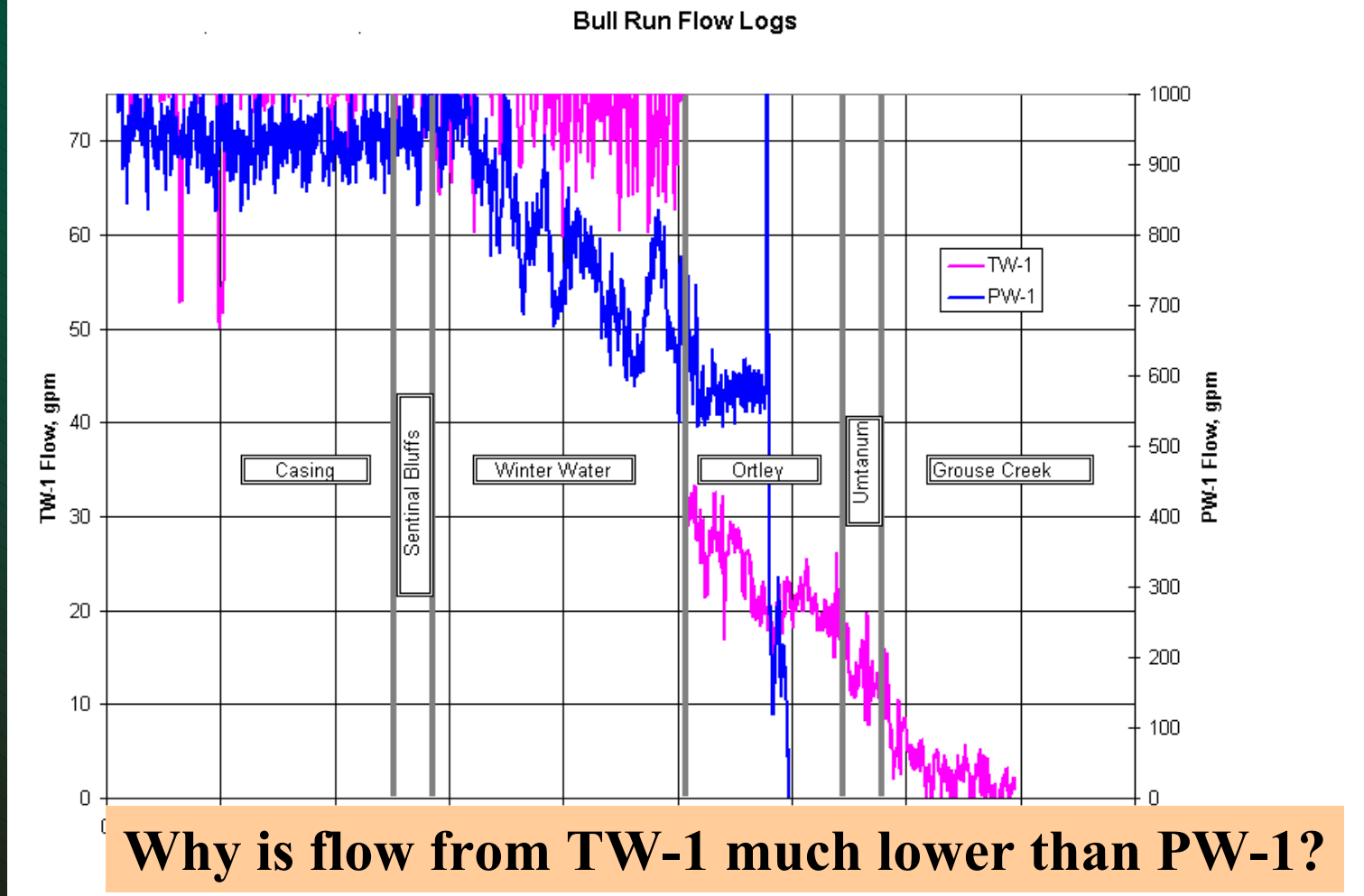
Flow Logging Indicates Primary Zones of Inflow to Wells



Why is flow from TW-1 much lower than PW-1?

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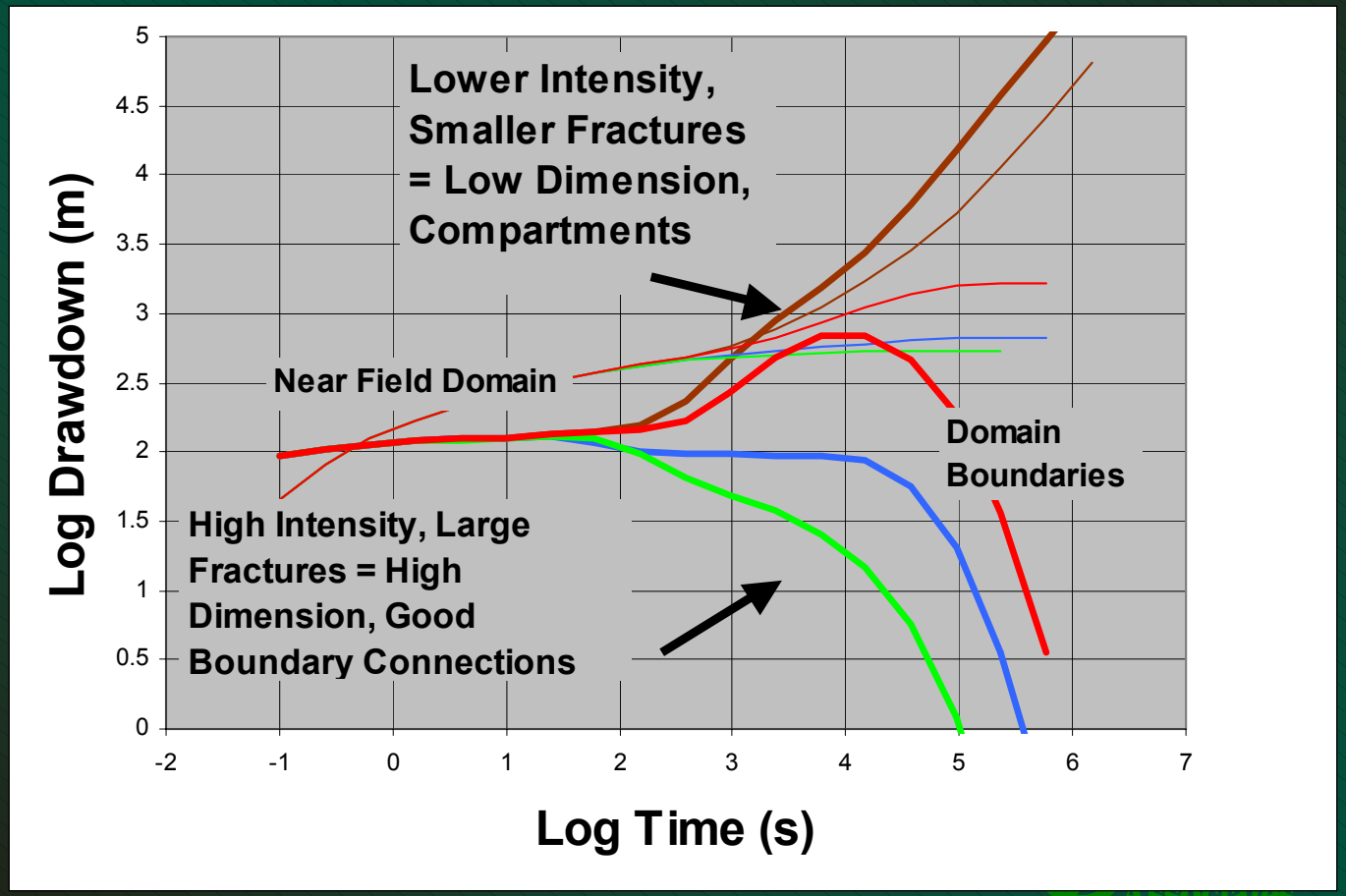
Hydraulic Testing Set Up

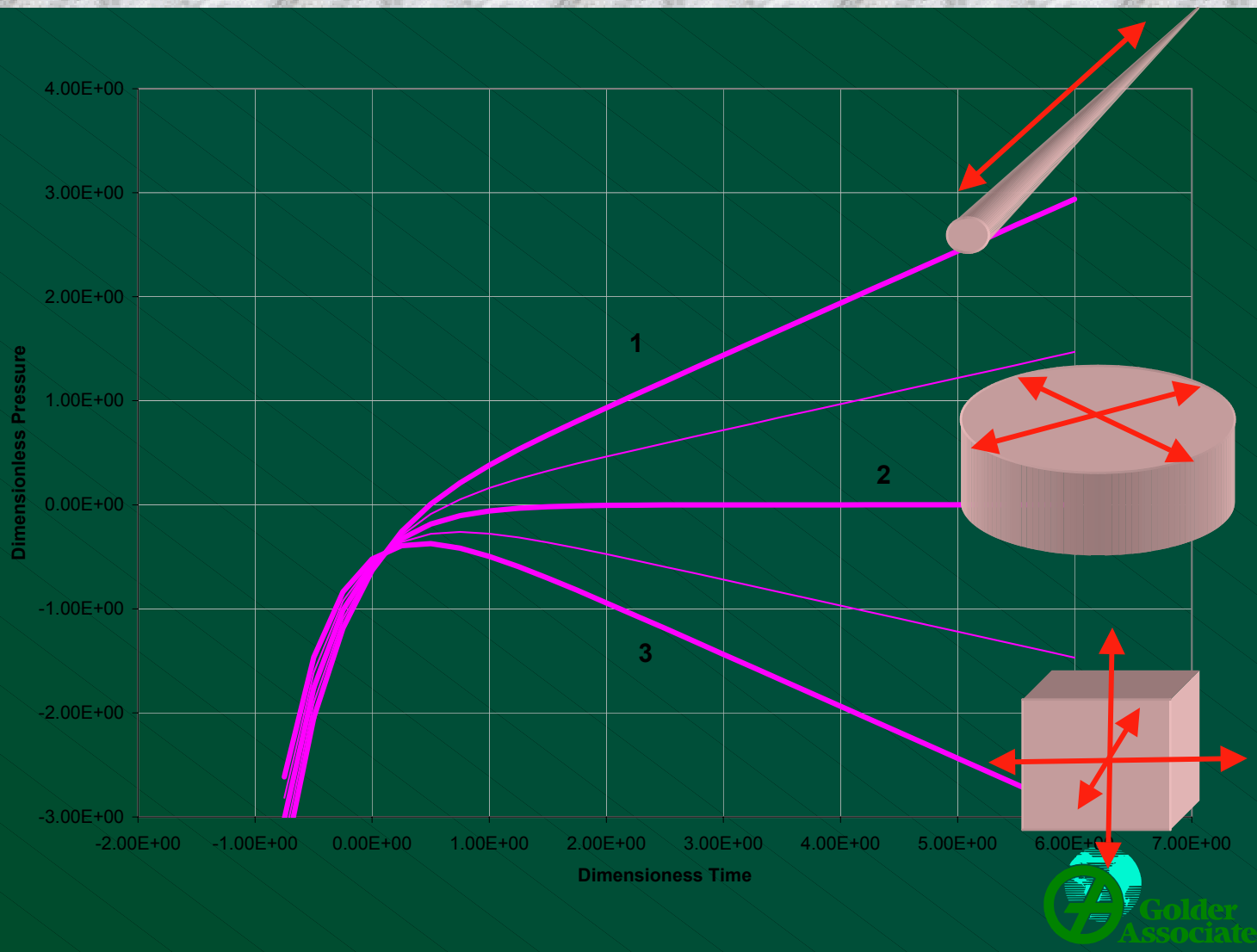
Flow Testing Pilot Well 1 at 667 gpm

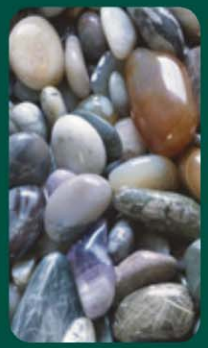
Flow Test Analysis - Derivative

Derivative "maps" T versus distance



Dimension Information from Well Tests



Purpose of Analysis

- Used Interpret/2 Model with Derivate Analysis to:
  - Investigate local and regional aquifer properties
    - T, S,
  - Understand flow behavior
    - Fracture flow or porous media
    - Boundary Conditions
    - Local Fault Structure
    - Well Conditions/Skin/Damage Zone

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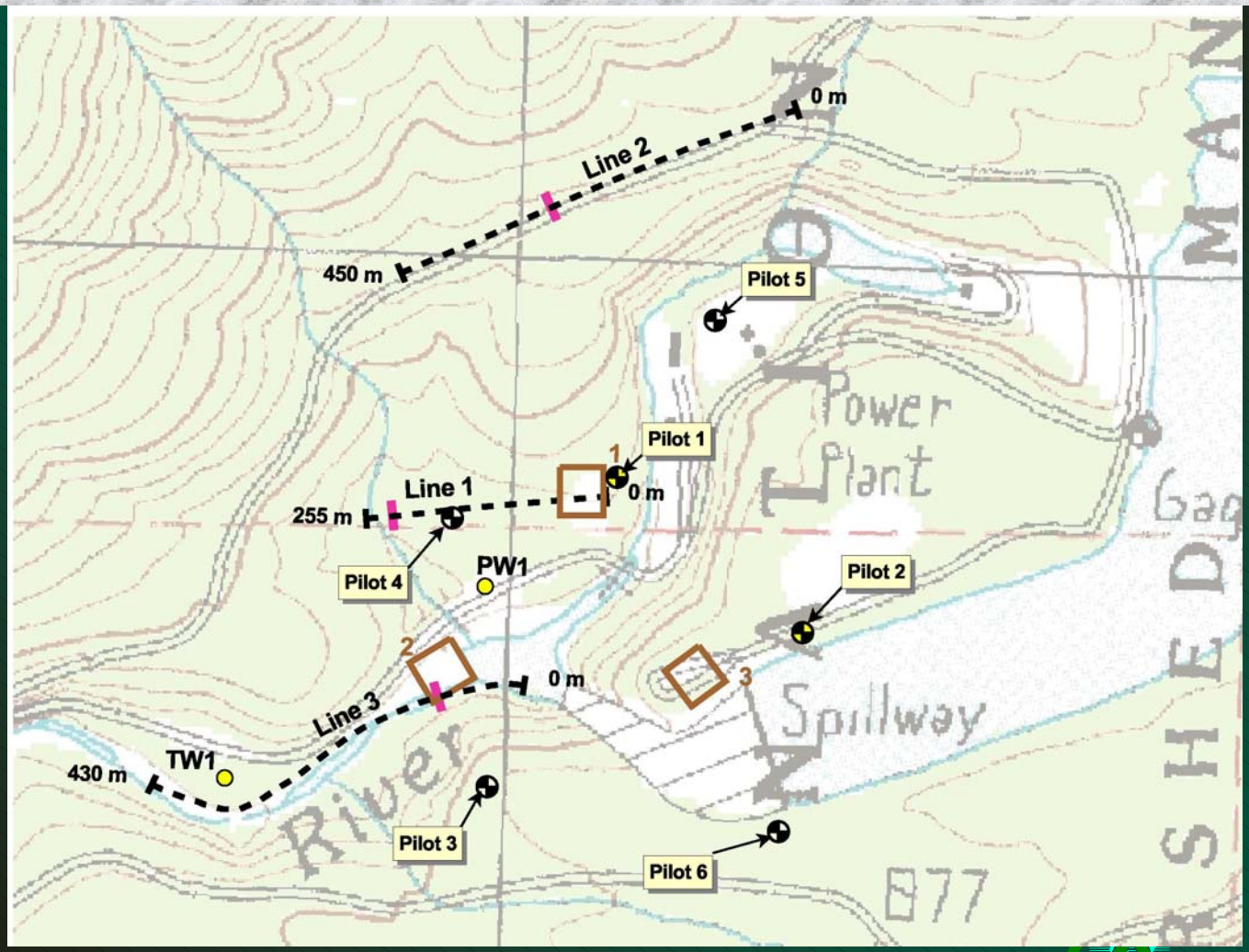
Well Locations



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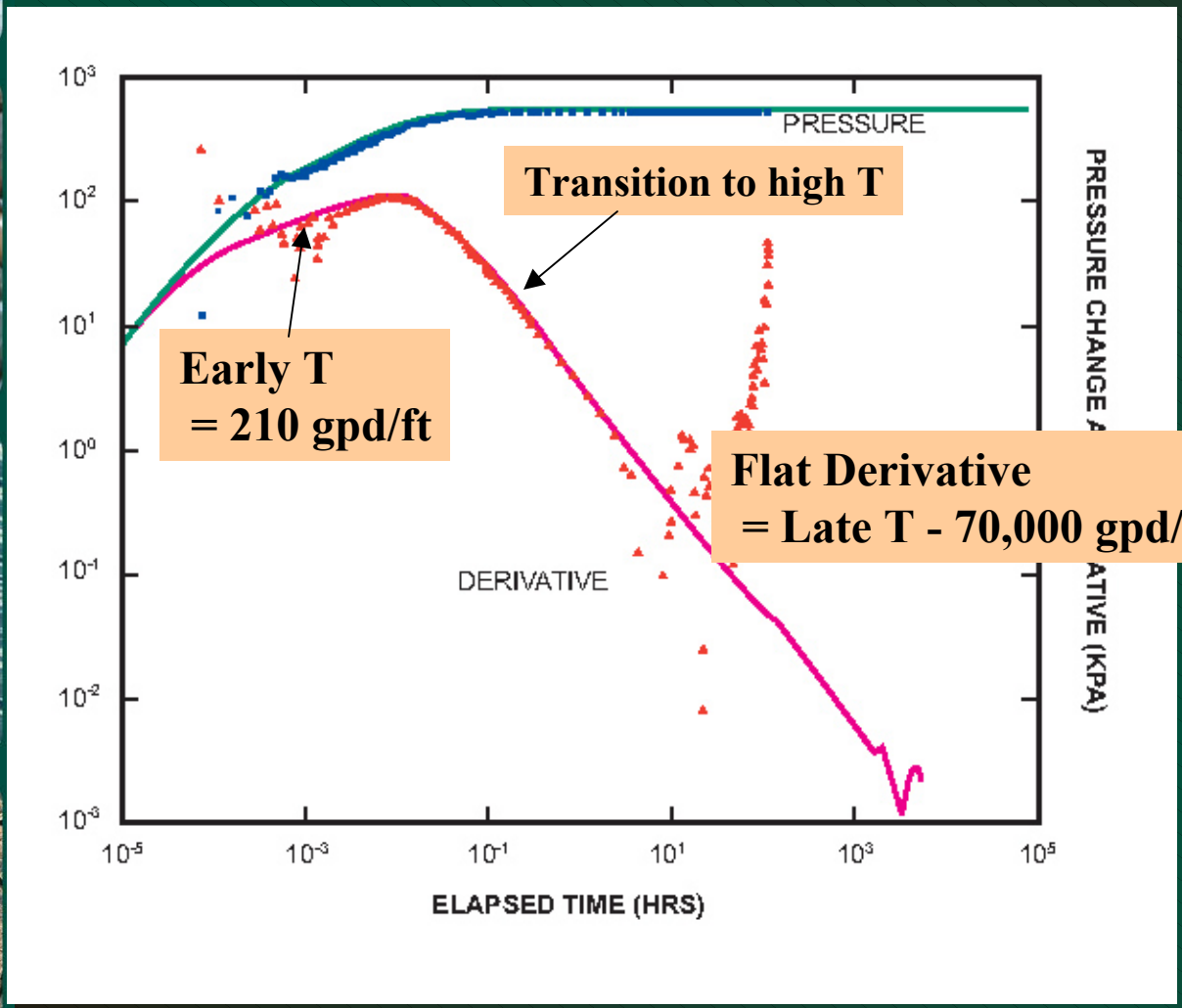
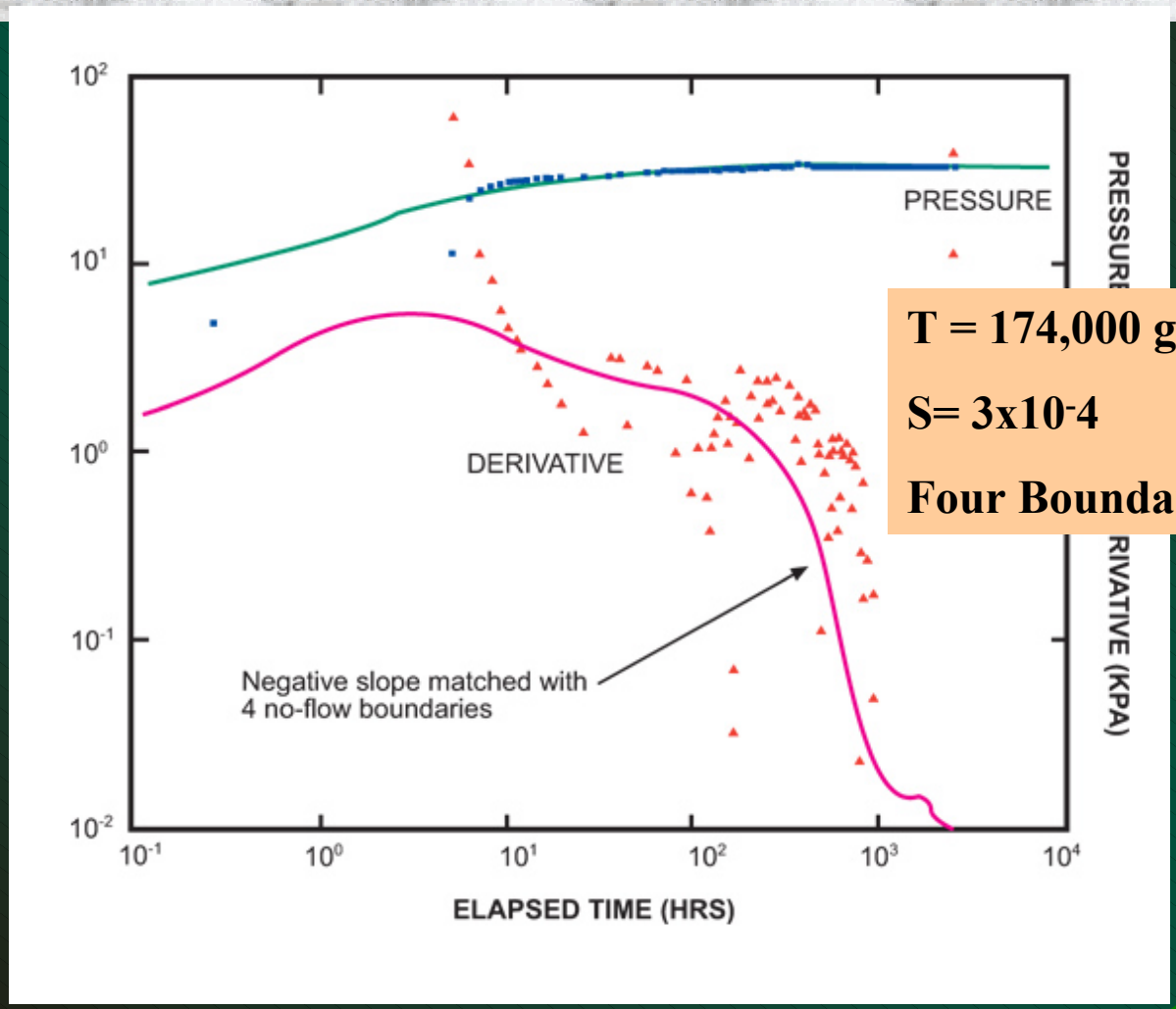
TW-1 Flow Test Analysis



PW-1 Flow Test Analysis



T = 174,000 gpd/ft

S= 3x10-4

Four Boundaries @ 18 km

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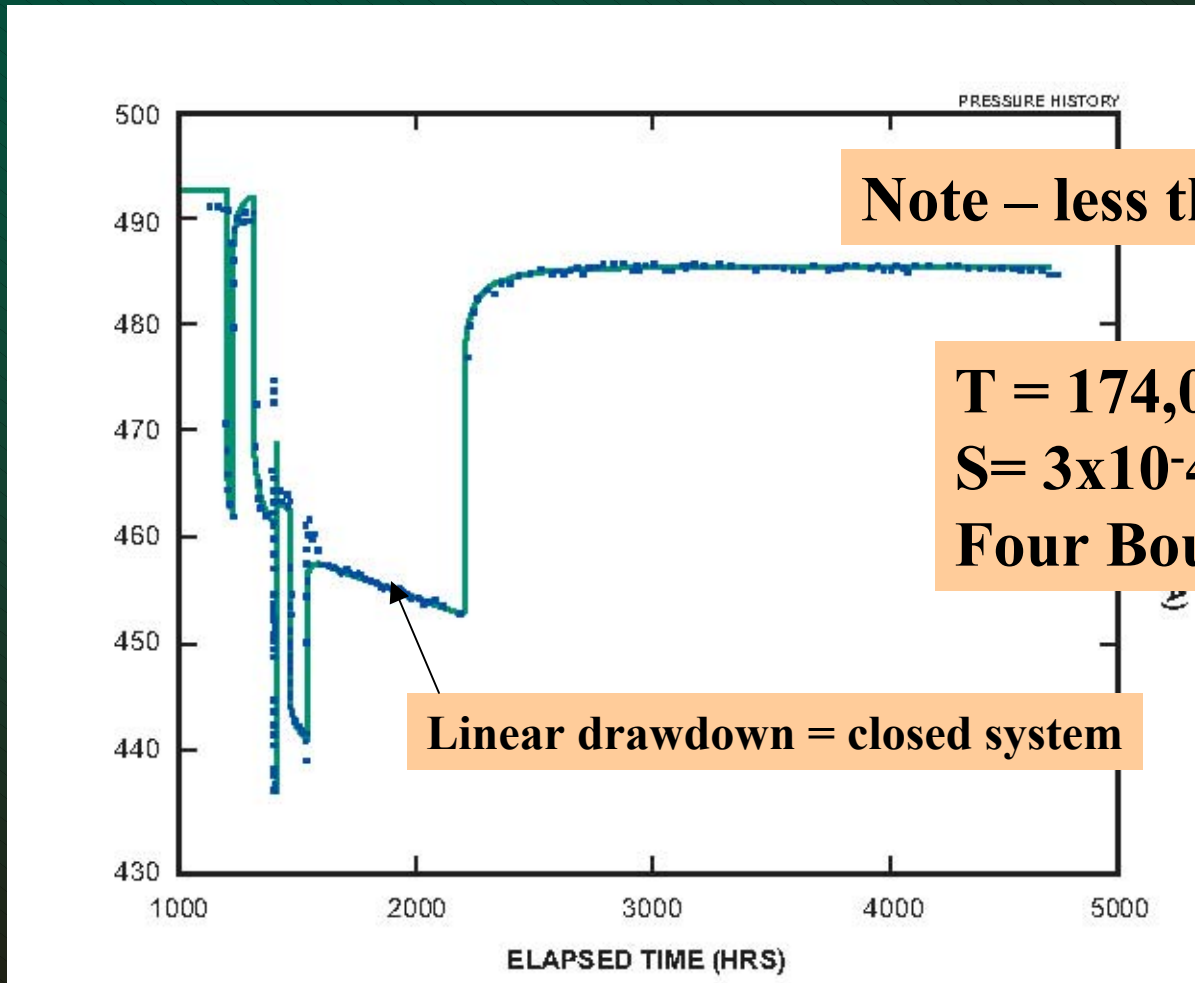
Simulation to Long-Term Flow Test

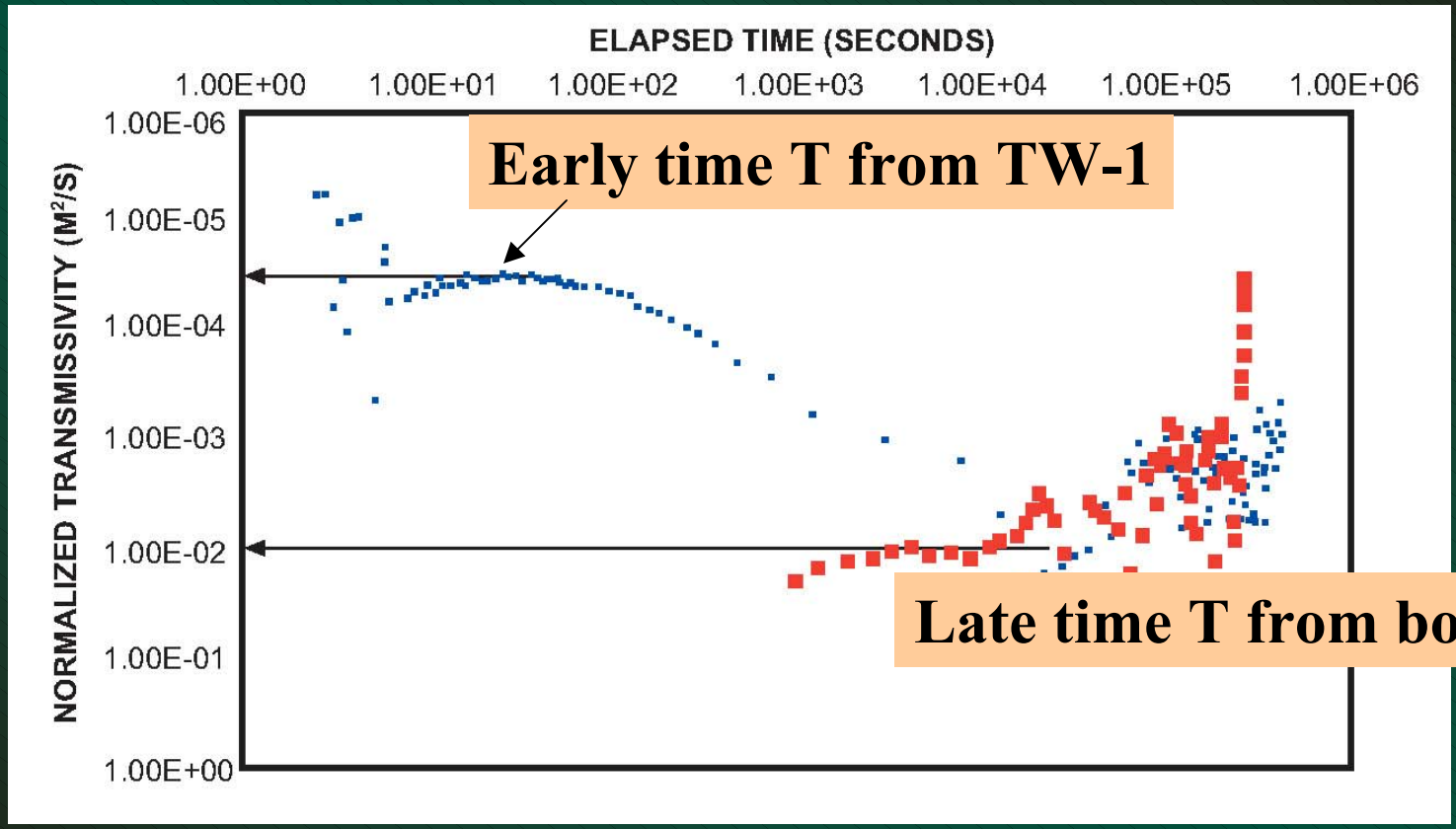


Note – less than full recovery

T = 174,000 gpd/ft
S= 3x10^{-4}
Four Boundaries

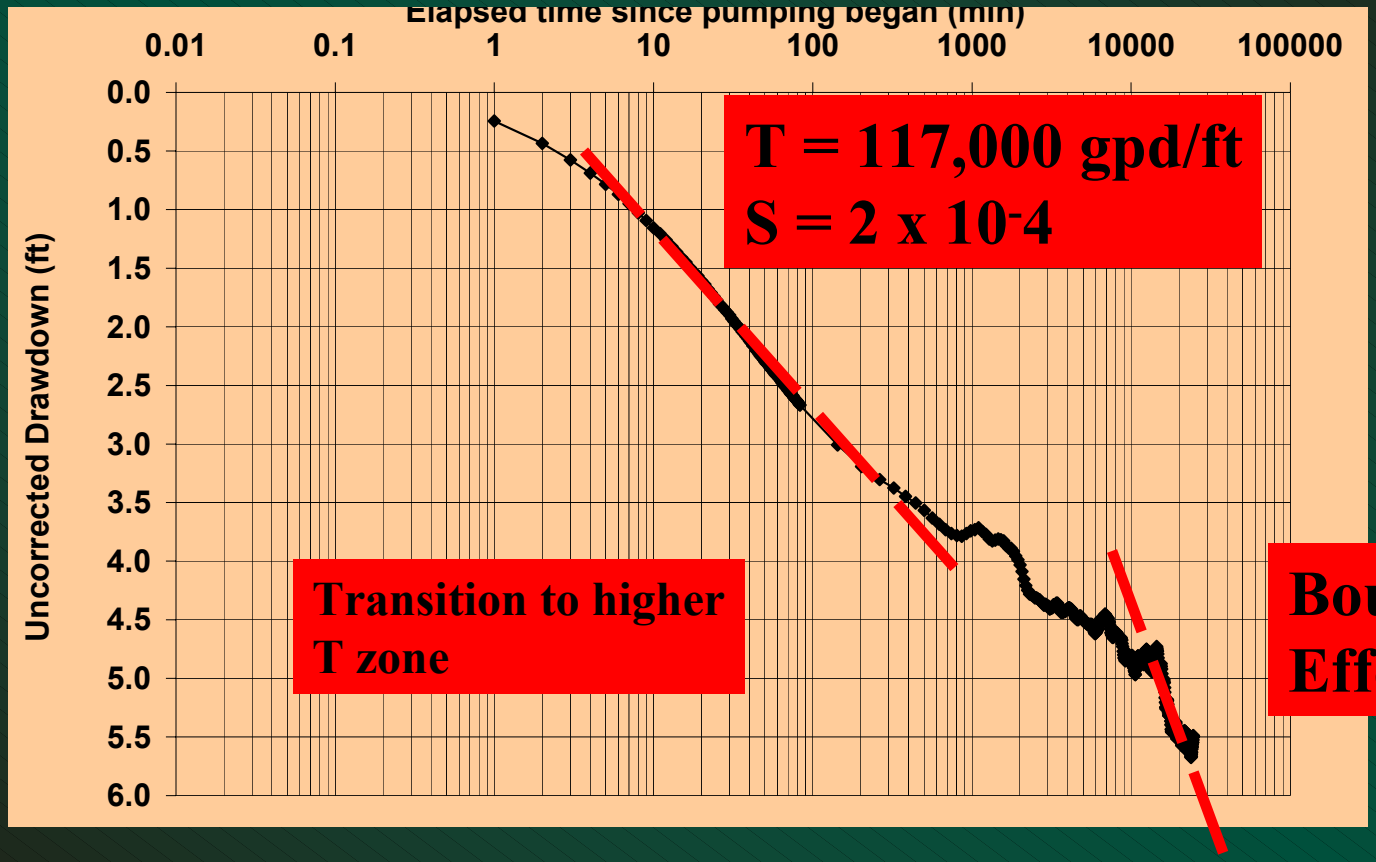
Linear drawdown = closed system

Normalized Transmissivity Plot



Shows late time aquifer response from both tests is similar

Drawdown in PW-1



Pilot Well #1 Flow Test – 667 gpm

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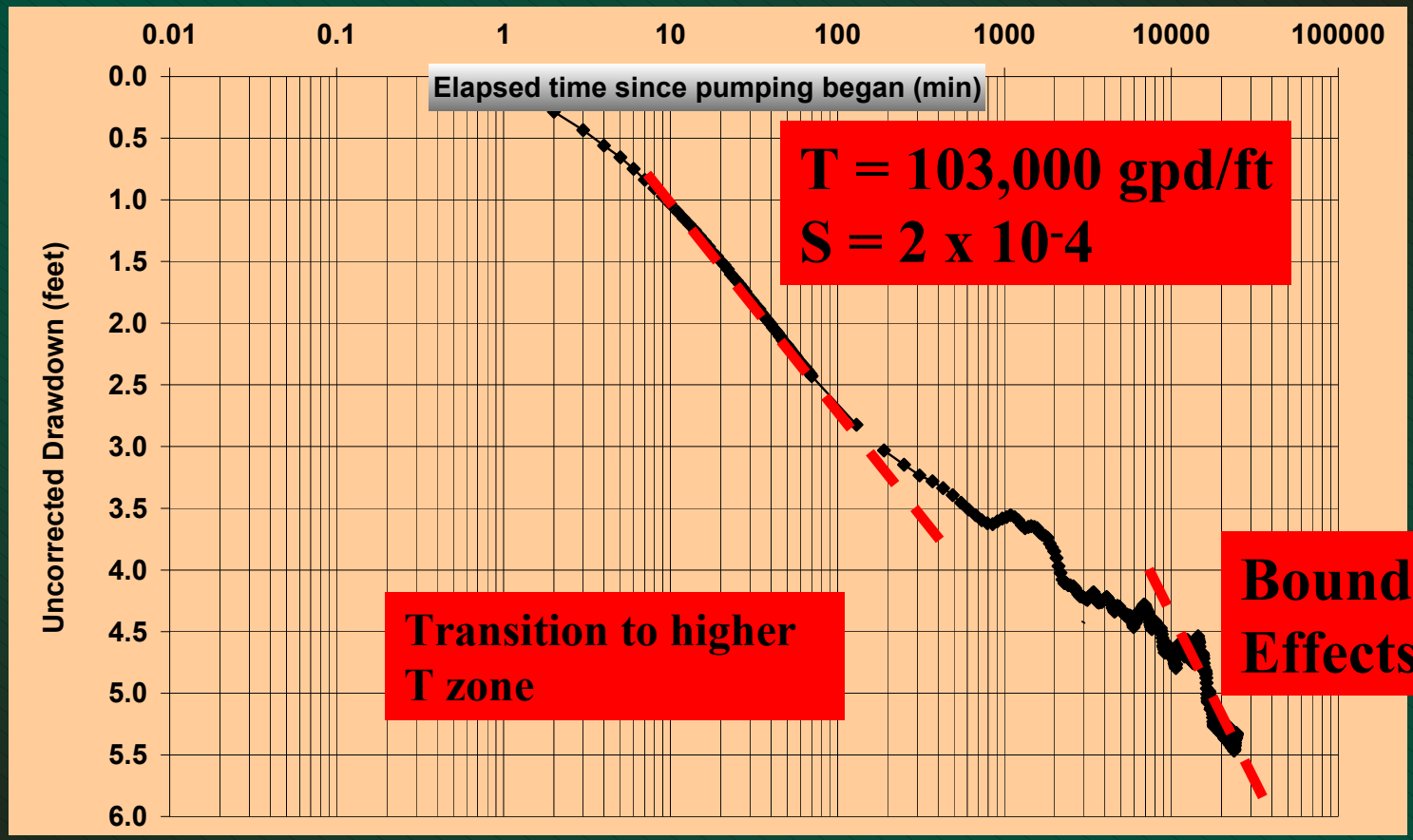
Drawdown in Pilot Well 2



Pilot Well #1 Flow Test – 667 gpm

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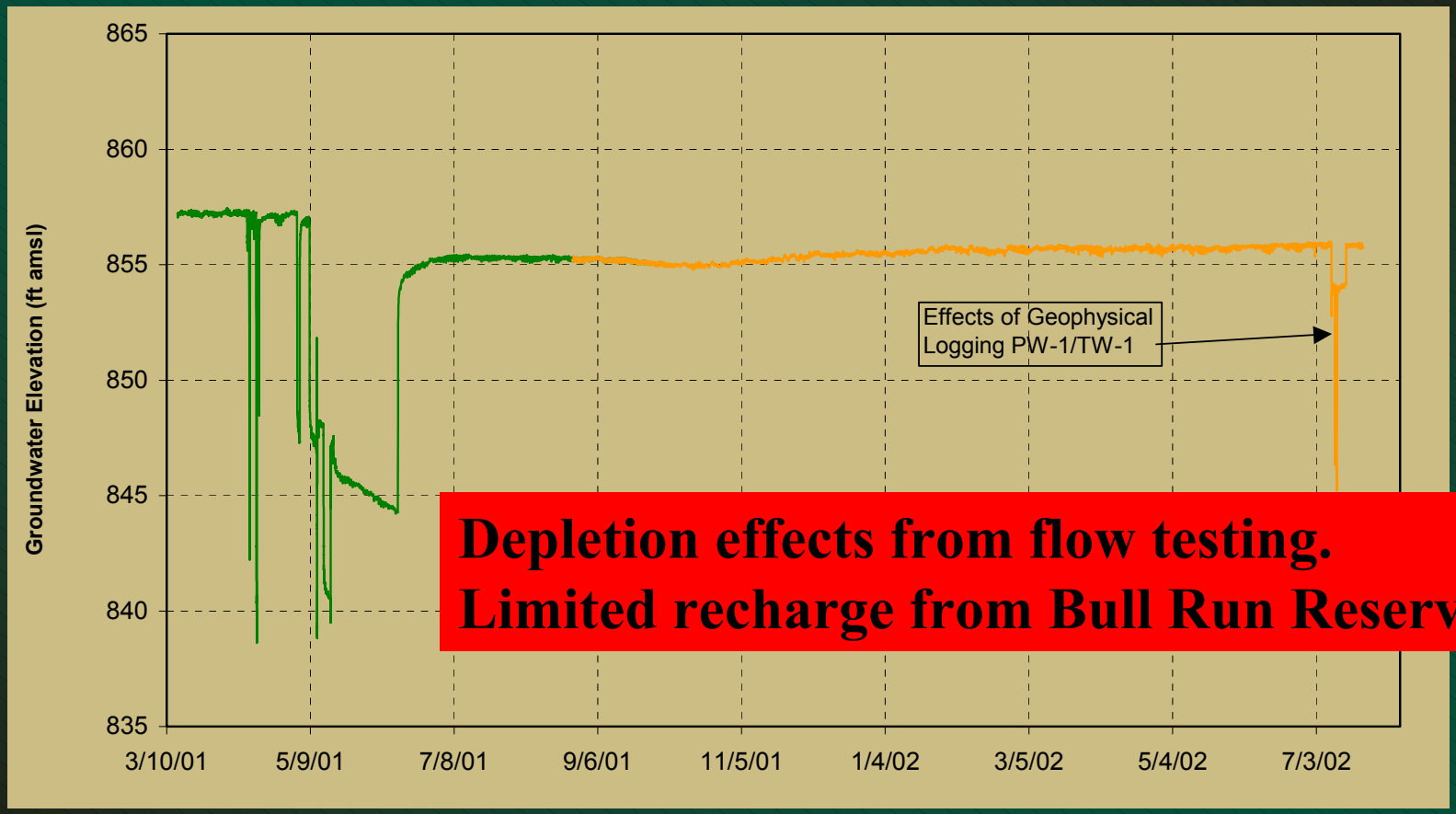
Long-Term Groundwater Levels



Depletion effects from flow testing.
Limited recharge from Bull Run Reservoir

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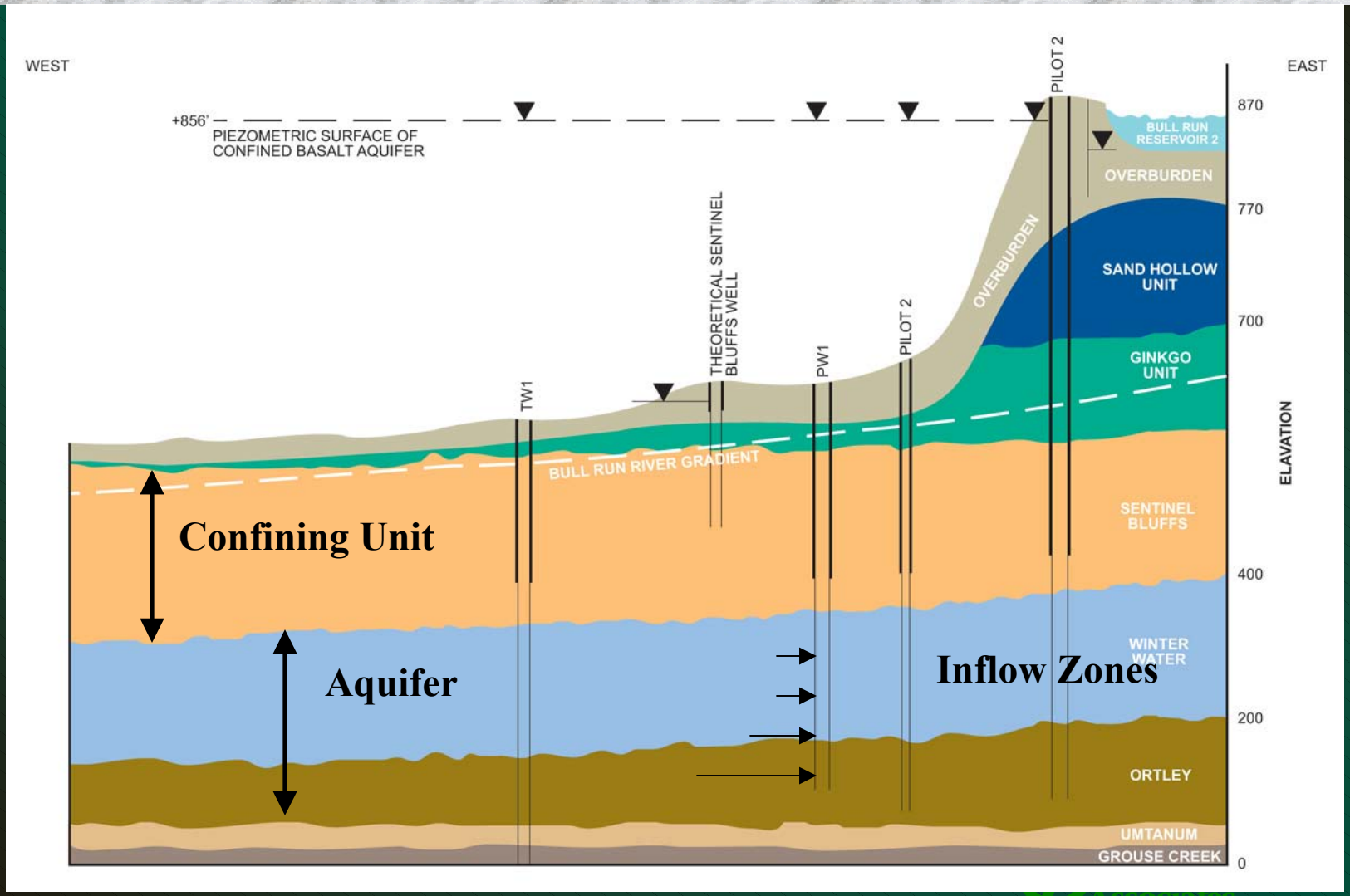
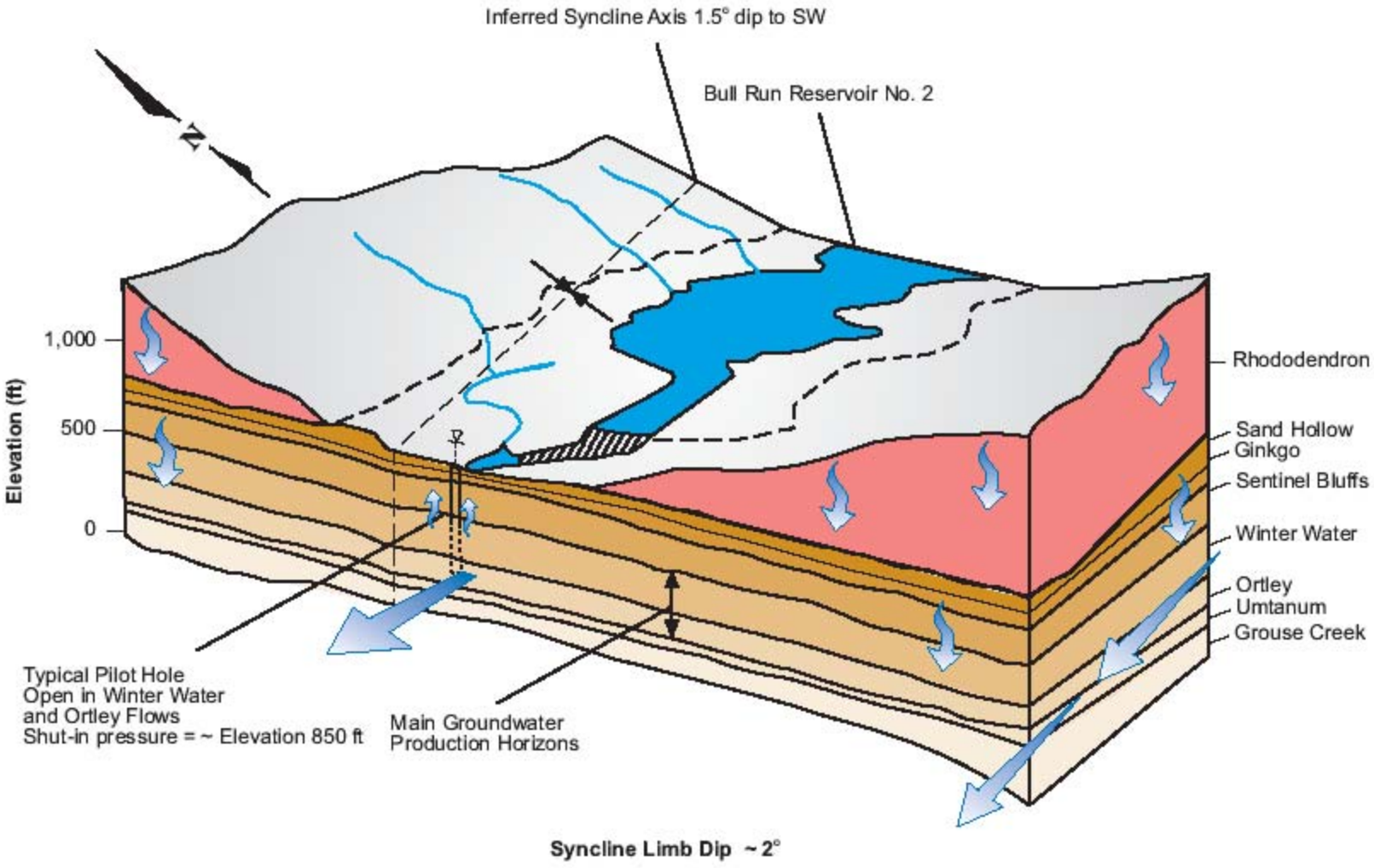
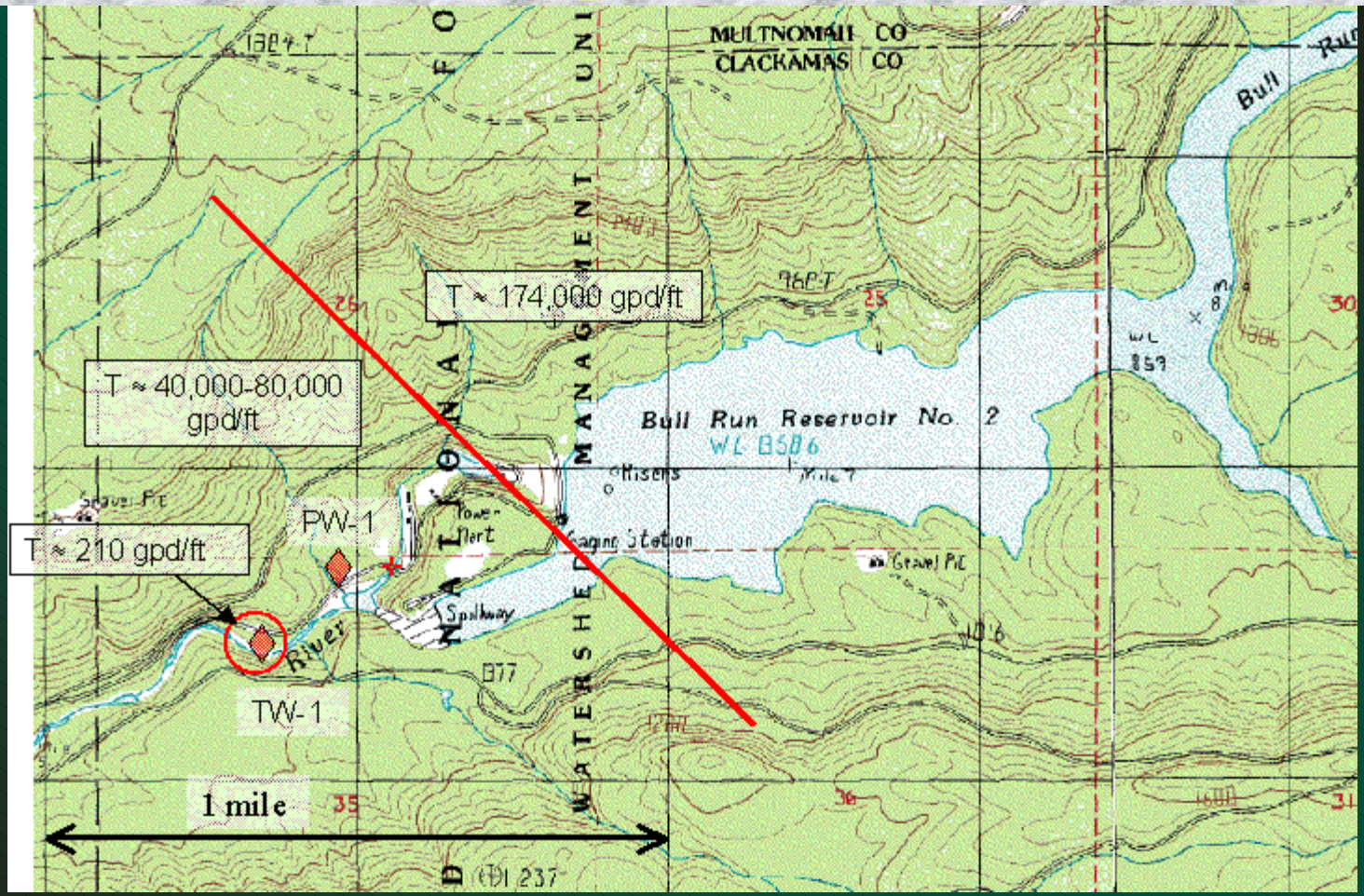
Bull Run Hydrostratigraphy



Conceptual Model



Spatial Distribution of Hydraulic Properties



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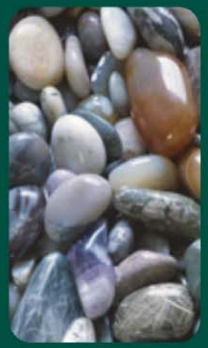

Conclusions

- Regional Aquifer in Winter Water and Ortley flows within Bull Run
- Highly Transmissive and Confined Aquifer
- Limited Recharge/Leakage
- Large well yields in high T areas
- Low yield at TW-1 a local effect (well construction?)
- 10 MGD feasible, provided long-term drawdown “managed”

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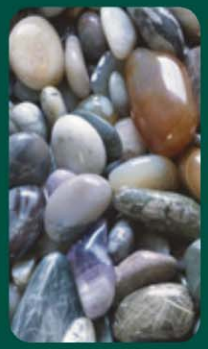

Next Steps

- Drilling & Testing of Additional Pilot Wells
- Drilling of Several Production Wells
- Water Rights Process
- Engineering Design Process

Further Information:
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